REMARKS

Reconsideration and allowance of the above referenced application are respectfully requested.

Initially, the Examiner is thanked for the telephonic interview that was conducted on December 7, 2005. The substance of that interview is summarized and expanded on, below.

Claims 1, 7, 10 and 13 stand rejected under 35 USC 102(e) as allegedly being anticipated by Sugawara et al. In response, claim 1 is canceled, and claims 2, 3 and 4 have each been amended into independent form. Each of the amended claims also includes the additional limitation that the first II-VI compound semiconductor layer (that has zinc and selenium) is provided between the metal electrode and the third compound semiconductor layer to prevent atoms in the metal electrode from reacting with atoms in the II-VI compound semiconductor layer.

This is completely different than the subject matter that is suggested by the cited prior art. In fact, the ordinary expectation in the art is that the Zn-Te layer should be connected to the metal electrode, in view of the fact that those having ordinary skill in the art understand that zinc tellurium produces excellent ohmic contact. See the attached document, "Labeled II-VI Semiconductor Materials and Their Applications", to show the usual expectation of those having ordinary skill in the art that Zn-Te forms <u>excellent</u> ohmic contact layers. The

presently claimed combination, on the other hand, prevents the atoms in the metal electrode from reacting with atoms in the II-VI compound semiconductor layer, and thereby is distinct from the cited prior art.

It is believed that all of the pending claims have been addressed in this paper. However, failure to address a specific rejection, issue or comment, does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above are not intended to be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

Attorney Docket No.: 14925/010001/FP03-0355-00US-SE

Applicants ask that all claims be allowed. Please apply the 3 month extension of time fee in the amount of $1,020, the extra claim fee in the amount of $400, and any other applicable charges or credits, to Deposit Account No. 06-1050.

Respectfully submitted,

Date: Dec. 7, 2005

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II-VI Semiconductor Materials and Their Applications

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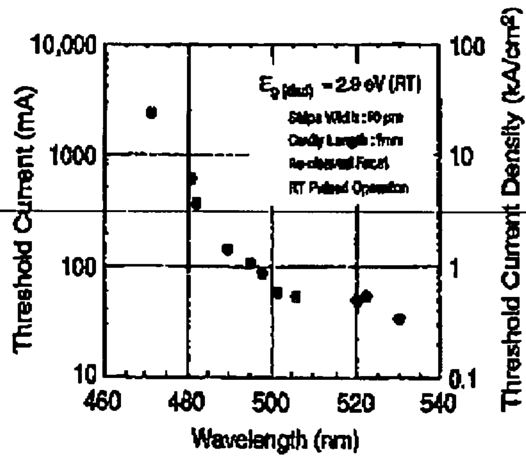

Figure 3 Relationship between threshold current (density) of various ZnMgSSe-based lasers without facet coating and lasing wavelength under pulsed operation at RT. The band gap energy of the ZnMgSSe cladding layers is 2.9 eV (RT) (after Reference [18]).

3.2 Ohmic Contacts to *p*-Type Layers

The applied voltages needed to produce the lasing action of the early II-VI lasers were very large (~20 V) [1,7]. Obtaining good ohmic contact to *p*-ZnSe was a fundamental problem in device fabrication. Because of the deep valence band of ZnSe which lies ~6.7 eV below the vacuum level, all metals deposited onto p-ZnSe give rise to large energy barriers (~1.5 eV). This high operating voltage causes a thermal problem in CW operation. Several attempts have been made to reduce the applied voltage. Employing an epitaxial layer of semimetal HgSe was found to decrease the metal-semiconductor interfacial barrier [20]. A blue LED containing HgSe/graded *p*-ZnSeTe contact layers produces 20 mA at 3.2 V. Fan et al. reported a low-resistance quasi-ohmic contact to *p*-ZnSe which involves the injection of holes from heavily doped ZnTe into ZnSe via a ZnSeTe pseudo-graded band gap region [21]. The contact resistance is found to be in the range of $2\text{–}8 \times 10^{-3}\,\Omega\mathrm{cm}^{2}$. Hiei et al. proposed a similar ZnTe/ZnSe structure with a different concept involving resonant tunneling through the multiple quantum well (MQW) region [22]. Employing this ZnTe/ZnSe structure, a threshold voltage of 3.3 V was achieved for CW operation [23]. Applying at least 2.4 V, which is the built-in potential, is needed for population inversion. Hence, the operating voltage is no longer a serious obstacle. However, it is also true that contacts must be carefully grown. Several groups have studied how to improve the formation of ohmic contacts and found that the formation strongly depends on growth conditions, such as doping and growth temperature [24,25]. When the nitrogen concentration of the ZnSe/ZnTe MQW or ZnTe top contact layer increased, the turn-on voltage and resistance of the structure increased [24]. Lowering the growth temperature of the contact and reducing the thickness of the ZnTe top layer drastically lowered the contact resistance [25]. The proposed explanation for these phenomena is that nitrogen diffusion from the ZnTe layer into the ZnSe layer underneath can lead to overcompensation in the *p*-ZnSe layer, while Kijima et al. [26] pointed out the importance of the stress induced by a lattice mismatch between ZnTe and ZnSe (~7%) in the reduction of net acceptor concentration in the ZnSe:N layer.

It should be noted that a 400-hr device lifetime [27] has established the reliability of *p*-contact (AuPtPd/*p*-ZnTe/*p*-ZnTe-ZnSe MQW/*p*-ZnSe in this case) up to 400 hr, as well the reliability of the active layer. Furthermore, the stability of a ZnSe/ZnTe contact for more than 1000 hr has recently been established, as is discussed in section 5.2 [26], although the large lattice mismatch can lead to stress and dislocations in the contact regions. For making a nearly lattice-matched contact layer, the BeTe/ZnSe system is recognized to be an attractive alternative, as is discussed in detail in another chapter of this book.

3.3 Devices

With parallel progress in device lifetimes, much work related to device design has been done in order to improve device performance (Table 1), such as low-threshold current and the controlled transverse optical mode. Here, we describe several device structures reported and their characteristics.

3.3.1 Gain-Guided Lasers Gain-guided lasers are simple to fabricate since they have no artificial structure to provide lateral optical confinement. (The lateral confinement induced by heating is significant in gain-guided II-VI lasers, as discussed in section 4.2.) Hence, this structure is suitable as a device for evaluating material quality and the structural design of stacked layers. A schematic structure for a gain-guided SCH laser is shown in Figure 2. The *p*-contact layers are chemically etched off, leaving a 10 µm wide mesa stripe. An insulating layer is deposited on the exposed *p*-ZnSSe layer to reduce the current path.

Typical light output-current (*L-I*) and voltage-current (*V-I*) characteristics under CW operation are shown in Figure 4 [27]. The CW threshold current (I_{th}) is 28 mA, corresponding to J_{th} of 431 A/cm^2 and the operating voltage (V_{op}) is 5.3 V for a 650 µm long device with a high-reflectivity (HR) facet coating. The lasing wavelength is typically ~515 nm. With antireflection (AR)/HR coating, the maximum output power reaches 87 mW without a noticeable kink, as is shown in Figure 5 [28]. This result suggests that catastrophic optical damage (COD) is not a serious problem when devices are applied to rewritable optical disk systems requiring high power. High-temperature operation is also important for practical use. The gain-guided laser has demonstrated 80°C operation at 10 mW, which is encouraging data [28]. Figure 6 shows the far-field patterns from a gain-guided device. The full width at half-maximum (FWHM) of beam divergence angles is 2° and 27° in the directions parallel and perpendicular to the junction plane, respectively [29]. Although the ratio of the perpendicular beam divergence angle to the parallel is larger than 10, the fundamental transverse mode can be realized.